Space Weather Technical Forecast

Issued on Wednesday, 10 January 2024 at 01:19 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Ongoing chance of isolated M-flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low solar activity with a number of C-flares from across the disc. There are eleven sunspot regions, dominated by two clusters. In the western/north-western disc, the previously active AR3536 remains an elongated spot but continues its slow decay, with a simple magnetic structure. AR3538 in the far northwest has been growing of late, but it is becoming difficult to assess the magnetic structure as it starts to near the limb. Nearby AR3539 has also grown, whilst the other regions in this area appear stable or in decay. The other cluster consists of two sunspots close together in the southeast, AR3940 and AR3941, both of which are showing little change, and overall also remain relatively stable. A single large region AR3545 has rotated onto the southeastern hemisphere, currently appearing as a simple unipolar spot. There is an as yet unnumbered NEW region which has developed fairly rapidly in the southeast, with signs of a weak delta spot within the main portion. This region will be watched closely for further developments.

Between approximately 09/1400-1600UTC a large double filament liftoff was observed in the southeast disk, the westernmost portion of which perhaps giving a slight chance of glancing influence into Day 4 (13 Jan), low confidence however and we await further modeling output. No other Earth-directed CMEs were observed in the last 24 hours in available imagery.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR and ACE at L1, showed a weak enhancement likely due to a weak connection to CH89/+. Wind speeds were at background levels, but slowly increased from around 320 km/s to near 400 km/s. Density has been average or below throughout. Interplanetary magnetic field (IMF) has been mostly weak but with a couple of brief moderate peaks around 8nT. The north-south component has varied weakly between +/-6 nT. Phi angle was mostly positive (away from the Sun). Geomagnetic activity was Quiet (Kp 0-2).

Energetic Particles / Solar Radiation: GOES18 high energy (greater than 10MeV) proton flux continued to gradually decline towards background. GOES16 high energy (greater than 2MeV) electron flux was at background. The associated 24-hour fluence was well below Active throughout. The 10/0000 UTC observation was 1.73e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is an ongoing chance of isolated M-flares, with a slight chance of isolated X-class flares.

Solar Wind / Geomagnetic Activity: There are two potential glancing CME impacts, one from 06 Jan, perhaps bringing a glancing influence early Day 1 (10 Jan), and another from 09 Jan, potentially arriving Day 4 (13 Jan). However these are both low confidence. Otherwise some slight interaction with the fast wind of CH89/+ remains possible Day 1 (10 Jan), but this is likely

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to have only a very limited impact on observed solar winds. Quiet geomagnetic conditions are expected to persist for much of the period, but may rise to Unsettled with a chance of Active in association with any glancing CME arrival.

Energetic Particles / Solar Radiation: High energy proton flux is forecast to continue declining towards background through the period, but with a slight chance of seeing further increases towards the S1 minor radiation storm threshold given any notable flaring. The high energy electron flux is forecast to remain at mainly background with no notable enhancements expected, and the associated 24 hour electron fluence persisting below the Active (1e8) threshold.

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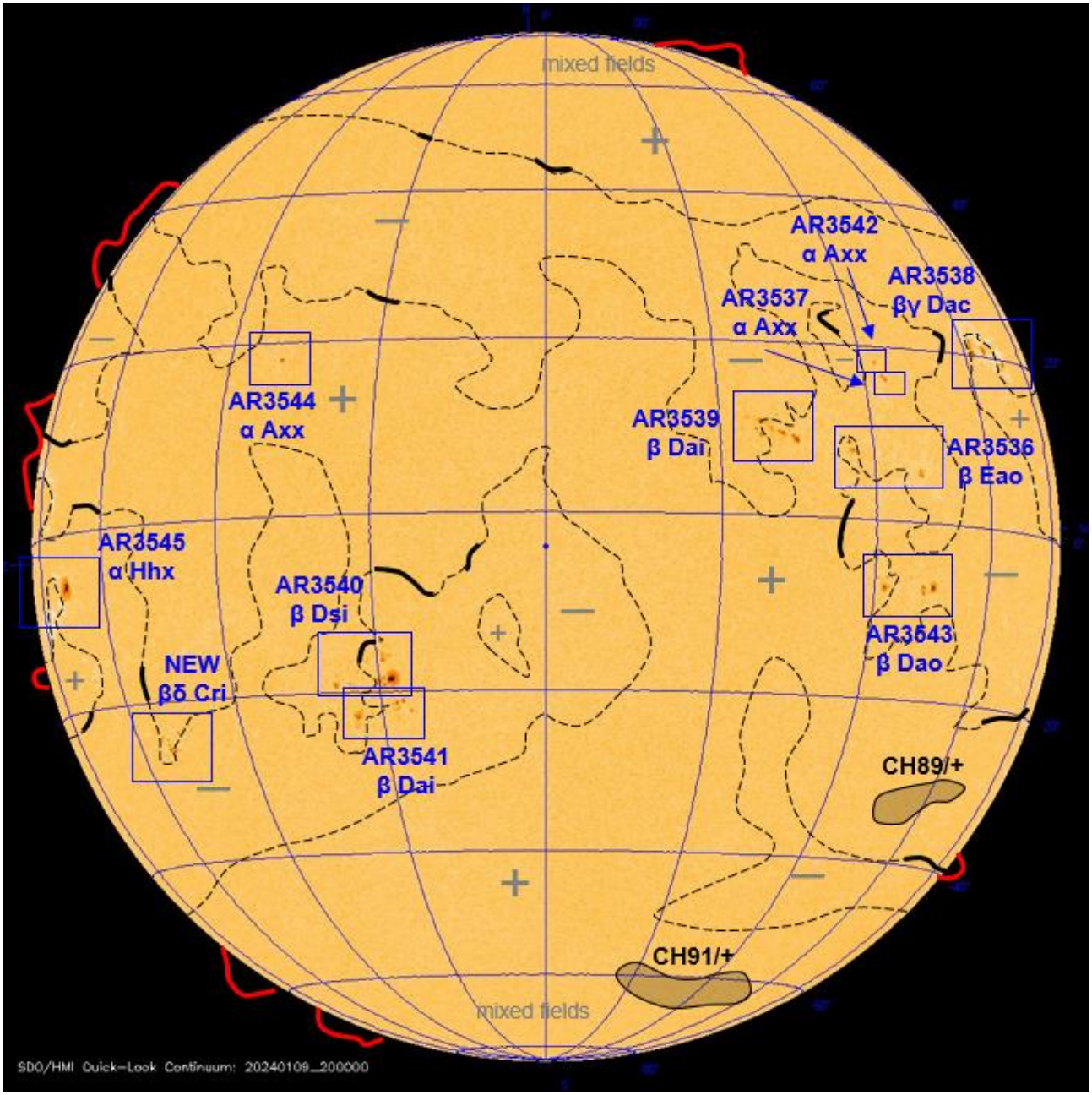
Figure 1. Solar Analysis Valid 09/2000UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:
There are two CMEs with potential for Earth-directed components. The first from a filament eruption on the 06 Jan perhaps passing close to Earth early Day 1 (10 Jan) with the potential for a very slight glancing blow, albeit with low confidence. The second CME is associated with a complex filament liftoff from the southeast disk on the 09 Jan. This perhaps giving a slight chance of glancing influence into Day 4 (13 Jan), low confidence however and we await further modeling output.

Solar winds currently near ambient, with only limited if any, connection to the high speed stream associated with CH89/+ apparent. This less than current MOSWOC Enlil expectations which would have Earth within a declining fast wind from CH89/+, around 450-500km/s. While some connection to this feature remains possible, it is perhaps now more likely that Earth is north of any fast wind that emanates from this coronal hole. Overall, peak winds of around 400-450km/s are possible Day 1 (10 Jan) before easing back to background into the period in the absence of CME influence.

Quiet geomagnetic conditions are expected to persist for much of the period, but may rise to Unsettled with a chance of Active intervals in association with any glancing CME arrival.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	1	1	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Latest MOSWOC ENLIL Ensemble showing the potential for CME glancing blows early in the period and into the 13 Jan. Note ENLIL is currently too fast with the solar wind speed, showing stronger connection to CH89 than expected further reducing confidence in output.

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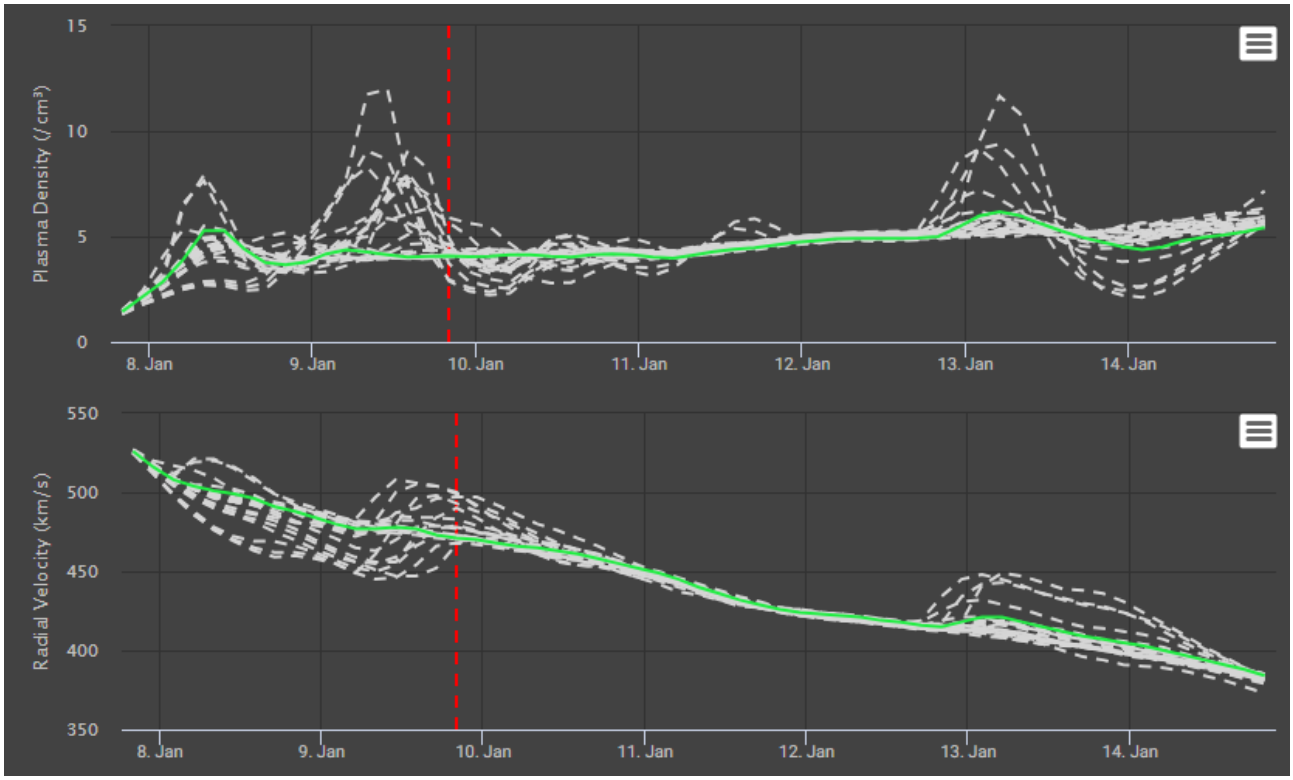

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Radio Blackouts - X-Ray Flares:
Low to Moderate activity is expected to continue into the period given the relatively large number of moderately complex spots on the disc, some of which continue to show signs of development and growth although these in the minority. One of these more complex areas, AR3538, will approach the western limb by Day 2 (11 Jan) perhaps seeing a reduction in flare risk. This balanced by the signal in far side soundings for one or more active regions to rotate onto the visible disk in the coming days.

Therefore the chance of an isolated M-flare and a slight chance of an X-class flare is maintained through the forecast period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	50	50	50	50
Very Active	R3 to R5 X Class	No	10	10	10	10

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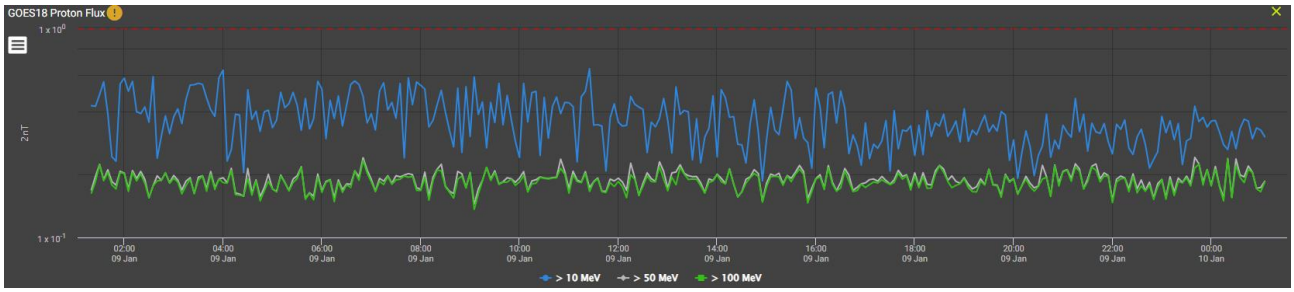
Solar Radiation Storms - (High Energy Protons):
GOES18 high energy (greater than 10MeV) proton flux is currently slightly above background, due to the lingering enhancement of the Dec 31 X5.0 flare, and are expected to continue to gradually ease in the absence of further enhancement. Any further notable flares will bring a risk of proton flux rising however, with this risk slightly increased due to the multiple spots in the western hemispheric. Therefore There remains a slight chance of reaching the S1 Minor Radiation Storm threshold in the coming days.

Please note: GOES-18 is currently being used as the primary proton instrument, with GOES-16 data currently viewed as unreliable due to a fault reported by NOAA.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	10	10
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 3: Latest 24hr GOES18 Proton Flux trace.



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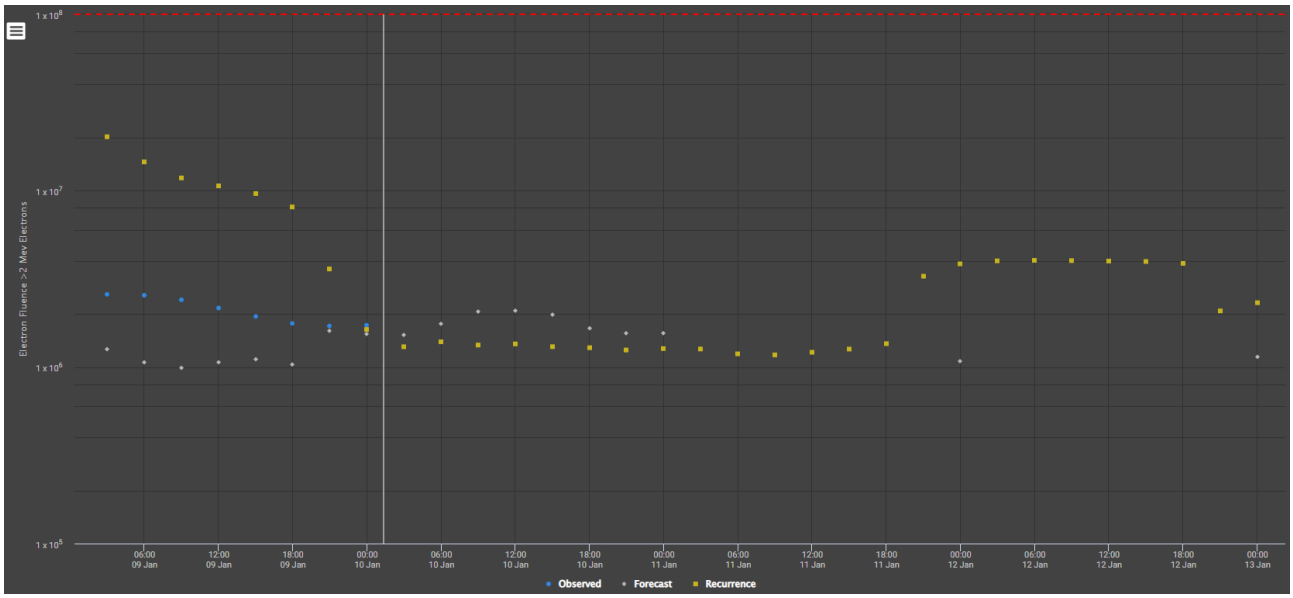
High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) as measured by GOES-16 at GEO is currently at background, and in the absence of any significant enhancement is expected to persist at this level, although brief periods of Moderate flux are possible Days 2-4 (11-13 Jan).
The associated 24 hour fluence is expected to remain below the Active threshold, with REFM output currently viewed as providing good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: Latest MOSWOC REFM model output.



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